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HOW TO GROW ALFALFA



ALFALFA is a perennial legume belonging to the same family as peas, beans, and clover.

The leading commercial varieties of alfalfa in the United States are the Common, Grimm, Turkestan, and Peruvian. Grimm alfalfa is superior to the Common in the North, and Peruvian is preferable for the Southwest.

Alfalfa succeeds best in a dry climate where water is available for irrigation. The best soils on the farm should be selected for the alfalfa field. It is practically useless to attempt to grow the crop on nonproductive lands to improve them.

It is best to precede alfalfa for a year or two with some cultivated crop, such as corn, potatoes, or cotton, to free the land from weeds. The ideal seed bed is a well-settled subsurface with a fine surface that is loose to a depth of 2 inches.

Alfalfa should be sown early enough to permit the plants to become well established before winter sets in. The rate of sowing depends upon the condition of the soil. In the East 20 to 25 pounds per acre is generally advised. In the West under irrigation 15 pounds is sufficient, while under dry-land conditions 8 to 12 pounds is ample. Except under very favorable conditions alfalfa should be sown without a nurse crop.

Except where alfalfa is grown under irrigation there is little to be gained by harrowing broadcast fields so long as the stand is satisfactory and the plants are making a good growth. Attempts to thicken up thin stands by resowing or other means nearly always result in failure.

Alfalfa should be cut for hay when the plants are well in bloom.

Alfalfa hay and pasture are readily eaten by all classes of farm animals.

Alfalfa produces seed in paying quantities only when the rainfall is comparatively light. The average yield per acre runs from 2 to 5 bushels.

HOW TO GROW ALFALFA.¹

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DESCRIPTION OF ALFALFA.

Alfalfa (*Medicago sativa* L.) is a herbaceous perennial legume belonging to the same family as peas, beans, and clover (fig. 1). Its flowers are borne in loose bunches, or racemes, and are of a purplish color. The pods in which the seed is produced are twisted spirally in one or two turns, similar to the shell of a snail. Each pod contains several small kidney-shaped seeds. The stems, which are usually not more than one-eighth of an inch in diameter, are erect and commonly reach a height of 2½ feet. They arise from a semi-woody base known as the crown. The root system is characterized by a distinct taproot, which in permeable soil extends to a considerable depth. The taproot has few to many branch roots. The leaves are in threes, like clover, and are arranged alternately on the stem.

HISTORY.

Alfalfa probably originated in southwestern Asia, although wild forms from which it might have sprung are found in China and Siberia. The name "alfalfa" is of Arabic origin and is translated to mean "the best fodder." This name is very generally used in America and is replacing the name "lucerne," also sometimes used in many sections, especially in the eastern United States and in Utah. The origin of the name "lucerne" is not quite clear, but it is supposed to be a corruption of the old Catalan name "userdas," whence comes the common name "laouzerdo," used in the south of France. From this by easy transitions the name "lucerne" or "lucerne" has been derived. It is supposed by some authors that the name came from Lucerne, one of the Swiss Cantons, but this supposition is incorrect.

¹ This bulletin supersedes Farmers' Bulletin 339.

Historical accounts indicate that alfalfa was first cultivated in Persia and that the Persians took it with them when they invaded Greece about 490 B. C., to provide forage for the horses and cattle

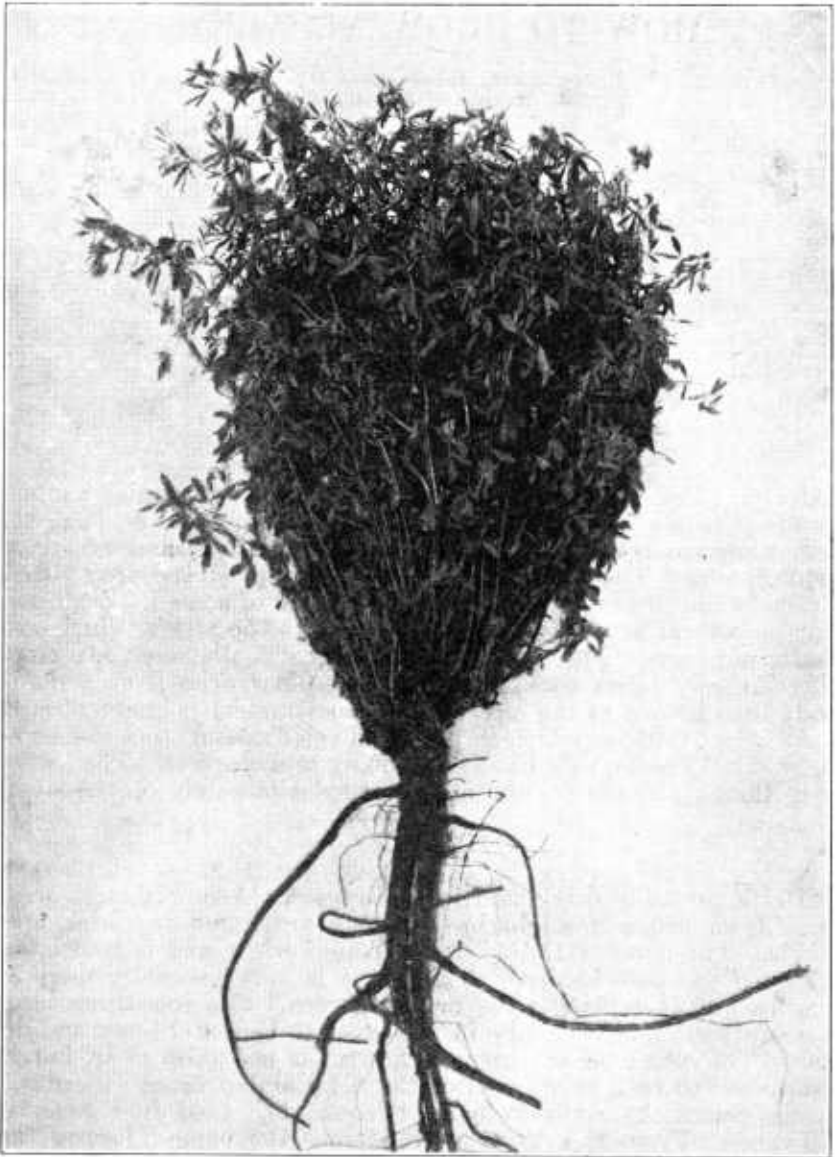


FIG. 1.—A typical alfalfa plant.

of their armies. It was apparently introduced in Italy during the first century and into Spain during the Moorish invasion in the eighth century. The Spaniards took alfalfa to South America and Mexico in the sixteenth century and doubtless to California and the

Southwest during their first expeditions. However, it was not until about 1850, when alfalfa was taken to San Francisco from Chile, that its rapid extension under irrigation commenced in the West.

The history of alfalfa growing in the Eastern States runs back for nearly two centuries. The colonists made repeated efforts to establish the plant as a forage crop, the first recorded attempts being made in Georgia in 1736, but as its soil and cultural requirements were not well understood the early efforts resulted in failure. As a result of the success which followed the introduction of alfalfa into the Western States attention was again directed to growing the crop in the East in the latter part of the nineteenth century, and from that time its acreage in the Eastern States has shown a slow but steady increase.

ACREAGE.

Alfalfa is one of the most important forage crops in the United States, exceeding in acreage any of the other perennial crops grown

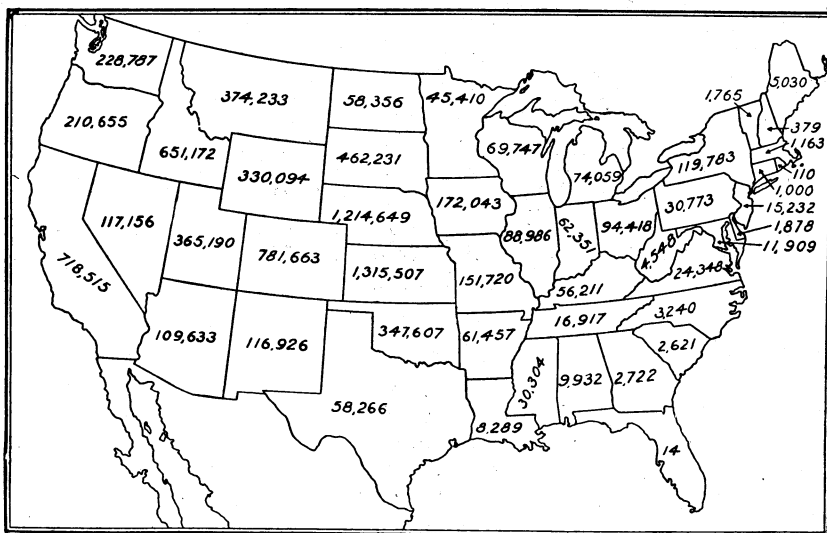


FIG. 2.—Outline map of the United States, showing the acreage of alfalfa by States, as determined by the census of 1920.

for this purpose with the exception of timothy alone or mixed with red clover. Its culture has extended very rapidly since it was first grown successfully in the West, and the acreage devoted to it has practically doubled every 10 years since the census report for 1899, when there were 2,094,011 acres in the United States. In 1909 there were 4,707,146 acres and in 1919 8,624,811 acres. By far the greater part of the alfalfa acreage is west of the Mississippi River, although the proportion east of it has increased steadily for several years. In 1899 this amounted to 1.1 per cent of the total; in 1909, 3.9 per cent; and in 1919, 8.45 per cent. In 1919 the leading States in alfalfa acreage were as follow: Kansas, 1,315,507 acres; Nebraska, 1,214,649 acres; Colorado, 781,663 acres; California, 718,515 acres; and Idaho, 651,172 acres. The total production for the same year was 18,853,133 tons of hay, the average acre yield for the whole United States being

2.2 tons. This varied for the different States from less than $1\frac{1}{2}$ tons to slightly more than 3 tons per acre. In general, the highest average was produced in States where most of the crop was grown under irrigation.

The acreage for the various States as given in the census reports for 1919 is shown in Figure 2.

VARIETIES.

The leading commercial varieties of alfalfa in the United States are regional strains of Common, Grimm, Turkestan, and Peruvian.

Common alfalfa includes the greater part of the alfalfa grown in this country. Much of it traces originally to seed that was brought to California from Chile about 1850. The seed from the various

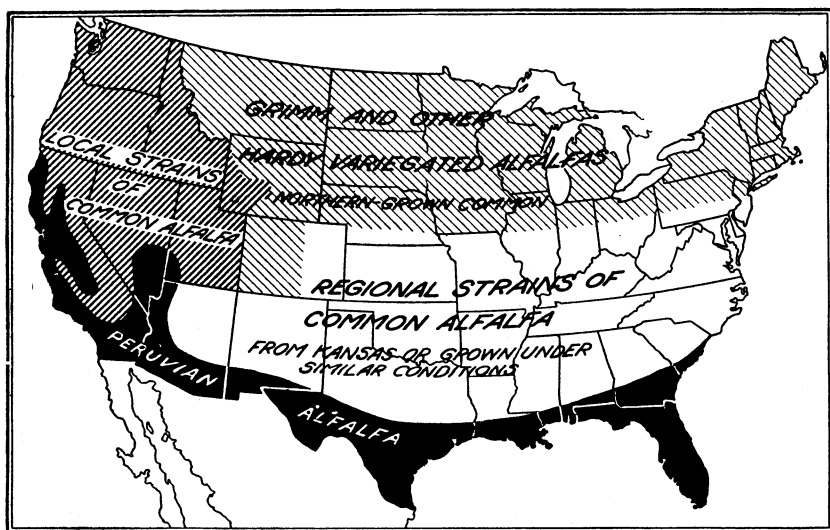


FIG. 3.—Outline map of the United States, showing the varieties or strains of alfalfa that are recommended for various sections, based upon climatic conditions.

States or sections is usually designated by the name of the State in which it was grown. Common alfalfa varies considerably in hardiness and other characteristics, depending upon the conditions under which it has been produced. Where it has been grown for several seed generations in the North it has acquired characteristics which render it more resistant to winterkilling than where it is grown southward. Whether this is due entirely to selective acclimatization or in part to actual adjustment of individual plants to local conditions is not very definitely known. At any rate, in purchasing seed an effort should be made to procure it from a source where the winters are approximately as severe as those where the seed is to be sown. In the southeastern one-fourth of the United States seed of Common alfalfa grown in Kansas and at similar latitudes has given larger yields of hay and for this reason is generally more desirable than seed produced in the Northern States.

Grimm alfalfa was brought to this country from Germany in 1857 by Wendelin Grimm. This variety is the result of a natural cross

between the well-known purple-flowered alfalfa (*Medicago sativa* L.) and the yellow-flowered alfalfa (*Medicago falcata* L.). It owes its superior hardiness in part to the presence of the yellow-flowered blood in its ancestry and in part to the natural selection that has taken place under the severe climatic conditions to which it has been subjected since its introduction into this country. Grimm alfalfa is recommended for the Northern States where the winters are severe. Southward, where winterkilling is not a factor to be considered, certain strains of common alfalfa will ordinarily give somewhat larger yields, and the seed of these is usually appreciably cheaper.

Turkestan alfalfa was introduced into the United States from Turkestan in 1898. Until very recently most of the alfalfa seed imported into this country has been from that source. The variety, although variable, resembles common alfalfa rather closely in its general characteristics. Selected strains have proved equal, if not superior, to the ordinary alfalfa in hardiness and drought resistance, but the commercial importations as a rule are decidedly inferior, especially for the humid districts.

Peruvian alfalfa is the least hardy and most rapid growing of our commercial varieties. It was first introduced into the United States from Peru in 1899. It seldom survives the winters where the temperature falls below 10° F. and is therefore suited only to the extreme South and Southwest. Where it survives the winters, Peruvian alfalfa gives somewhat larger yields than most other varieties. Two strains of Peruvian alfalfa are recognized, viz, "Smooth Peruvian" and "Hairy Peruvian." The latter usually produces somewhat heavier yields of hay than the former and is therefore preferable.

Cossack alfalfa, an introduction from Russia, is receiving an increasing amount of attention. It is a hybrid having variegated flowers and is adapted to about the same conditions as the Grimm variety. A more detailed discussion of these alfalfas, as well as of others of less importance, will be found in Farmers' Bulletin 1467, entitled "Commercial Varieties of Alfalfa."

VARIETIES FOR VARIOUS SECTIONS.

As a result of tests that have been conducted in this country for several years, the varieties that are best adapted to the various conditions have been pretty well determined, as shown in Figure 3. There are, however, more or less extensive areas in all parts of the United States where the conditions are so unfavorable for alfalfa that attempts to grow the crop nearly always result in failure.

PURCHASING SEED.

Before buying alfalfa seed there are three points upon which the purchaser should have information: The name of the variety, the section of the country in which it was produced, and the quality of the seed with regard both to germination and purity. Unfortunately, it is not possible to distinguish between varieties or strains of alfalfa by the appearance of the seed, and the tests that so far have been developed to assist in this connection are not of much practical value to the farmer. Except in the case of imported Turkestan seed, there is no easy means of telling from the appear-

ance of a sample of seed where it was grown. It is important, therefore, that dealings be had only with thoroughly reliable and intelligent seedsmen and growers.

The viability of the seed, or its ability to germinate, is quite clearly indicated in its appearance. Plump seeds of a bright olive-green color almost invariably germinate well, while shriveled seeds or seeds that are of a brownish color usually germinate poorly. Alfalfa seed turns reddish brown with age, and while some viable seed may possess this color, such seed should not be purchased without a germination test, even if it is offered at a price materially less than that asked for seed of a fresh olive-green color. When a germination test is desired it can be made by placing 100 seeds between cloths or blotting paper and keeping them moist and at a temperature of about 70° F. After five or six days most of the readily viable seeds will have sprouted. There will be some, however, that will remain hard, especially if they are of the variegated varieties. Many of these hard seeds will grow when put in the ground, and therefore they should be considered in estimating the percentage of germination. The Department of Agriculture, through its main seed laboratory and branch laboratories, is prepared to make a limited number of germination tests free of charge, but in order to prevent delay beyond the seeding time samples should be mailed to the department at least two months in advance.

With regard to the purity of alfalfa seed, every farmer should be able to recognize readily the most important weed seeds and other impurities that are commonly found in it. Seed to be acceptable should contain not more than 2 per cent of impurities. At the present time there is almost no attempt to adulterate alfalfa seed in this country, but every lot should be carefully examined for seed of noxious weeds, especially dodder, before it is purchased. The seeds of dodder are smaller than those of alfalfa, more nearly round, and have a pitted surface which can be detected only by the aid of a lens. As dodder is a troublesome weed and its seed can not readily be separated from alfalfa seed, dodder-free seed should be demanded by the purchaser. Seeds of buckhorn should always be looked for when samples of alfalfa seed are examined before purchasing. These seeds are shiny brown in appearance, boat shaped, and about twice the length of the alfalfa seed. Seeds of Russian knapweed should also be searched for carefully, as their presence indicates seed of the imported Turkestan variety. Russian knapweed is now occasionally found in some localities producing alfalfa seed in the United States, and its seed is likely to be found in domestic-grown alfalfa seed. While the seed laboratory of the Department of Agriculture is prepared to make a purity analysis of a limited number of samples free of charge for private individuals, it is very desirable that every farmer acquaint himself with the impurities and noxious weed seeds that alfalfa seed commonly contains, in order that there may be no serious delay in purchasing seed for sowing.

CLIMATIC AND SOIL RELATIONS.

The wide distribution of alfalfa in the world indicates a remarkable adaptability to climate and soil. While the crop requires considerable moisture to produce profitable yields of hay or pasture, it

does best in a relatively dry atmosphere where water is available for irrigation. There are few sections having a humid climate where the crop thrives. In the United States it succeeds at altitudes ranging from below sea level in the Imperial Valley, Calif., to 8,000 feet in the mountains of Colorado. It withstands hot weather well but is seriously affected by the cold weather of winter and early spring. To what extent extremely low temperatures alone are responsible for the death of alfalfa plants during the winter is not known, but this, together with other winter conditions, commonly results in high mortality. On poorly drained clay soils alternate freezing and thawing, such as occur in many sections, frequently do much damage to alfalfa by heaving the plants out of the soil and incidentally breaking the roots 6 or more inches from the crown.

Deep loams with open porous subsoils are undoubtedly best for alfalfa, but where other conditions are favorable the plant has a very wide range of adaptation in so far as soils are concerned. On account of the deep, penetrating character of its root system alfalfa does not thrive on a soil that has an impervious subsoil, hardpan, or bed-rock near the surface. Instances have been observed, however, where it made satisfactory growth on soils underlain at 18 inches by limestone ledges.

Good surface drainage and underdrainage are both necessary if alfalfa is to thrive. During the growing season complete submergence for 24 or 48 hours may do considerable injury, but when the plants are dormant they may remain under water several days with no serious damage. The formation of ice sheets on alfalfa fields during the winter months may result disastrously. It is sometimes possible to reduce the amount of damage to a minimum by breaking up the ice sheets with a disk or in a similar manner. Alfalfa seldom succeeds where the water table comes close to the surface, especially if the level of the water table fluctuates considerably.

In the eastern part of the United States rich river bottoms and soils of limestone origin are best suited to alfalfa, provided they are well drained. Here, where the climatic conditions are not generally favorable, only the best soils available should be devoted to the crop. On strong alkali soils, such as are frequently found in the West, alfalfa makes little or no growth.

CHOOSING A FIELD FOR ALFALFA.

In selecting land for alfalfa careful consideration should be given to the texture of the soil, its productivity, and drainage. Where possible, very sandy or very compact soils should be avoided. The character of the subsoil requires special attention. It is a waste of time and money to attempt to grow alfalfa on land that is underlain at shallow depths by hardpan or other impervious strata. The soil auger is of considerable assistance in determining the character of the soil and subsoil and should be used freely.

The most productive soils on the farm should be selected for alfalfa. It is practically useless to attempt to grow the crop on lands that are nonproductive with the idea of building them up, as is often done. Where good drainage does not exist naturally, it must be supplied by artificial means before alfalfa can be expected to suc-

ceed. Tile drains placed 3 feet below the surface will ordinarily lower the water table sufficiently to insure the satisfactory growth of alfalfa, other conditions being favorable. Complaints are occasionally received of tile drains being clogged by alfalfa roots, but this occurs so seldom that it need be given little consideration.

PREPARATION FOR ALFALFA.

THE PRECEDING CROP.

Alfalfa may be successfully grown after almost any crop provided proper attention is given to the preparation of the soil after the preceding crop has been removed. In deciding upon the preceding crop, however, one should be chosen that fits best into the particular system of farming and at the same time leaves the land in good condition for alfalfa. Due consideration also should be given to the time available for preparing the seed bed for alfalfa after the preceding crop has been harvested. As the young alfalfa plants are very tender and are likely to be killed by weeds during their early stages of growth, it is best to precede the alfalfa for one or two years with some cultivated crop. Corn or potatoes in the North and corn, tobacco, or cotton in the South serve this purpose admirably. In the Southern States crimson clover or rye and vetch may be sown after the removal of any one of these cultivated crops. The cover crop should be plowed under or cut for hay the following season and the land prepared for alfalfa. Where late summer or early fall sowing is practiced, canning peas, early potatoes, and early sweet corn leave the land in excellent shape and little further preparation is required. The heavy application of fertilizers which these crops require in many parts of the country will usually suffice for alfalfa. Except in the extreme North small-grain stubble may usually be worked up in time for late summer sowing provided the land has previously been treated so as to destroy the weeds. The chief objection to such a practice is the possible lack of moisture in the soil, due to the demands of the grain crop and the hot weather of summer. Crops which smother the weeds, such as cowpeas, may be used to precede alfalfa to good advantage. In the East it is not usually advisable to sow alfalfa on sod land, but in the Great Plains area this is done with a considerable degree of success.

PREPARING THE SEED BED.

The tender nature of the young alfalfa plants requires that the soil be in excellent tilth at sowing time. Many of the failures to secure a good stand may be traced directly to a poorly prepared seed bed. A desirable condition is a well-settled subsurface and a fine surface that is loose to a depth of at least 2 inches. Such a condition is best obtained by plowing the land in the fall, disking in the spring, and harrowing occasionally to keep down the weeds until sowing time. Where fall plowing is not practicable the land should be broken at least several weeks in advance of sowing. Meantime the soil should be disked and harrowed at frequent intervals to settle the seed bed. The "cultipacker" will be of considerable assistance in getting the soil in the desired condition. In the northeastern one-fourth of the United States, where alfalfa is sown the same season after the removal of a crop of small grain, it is generally better to

avoid plowing except on the heavier soils, as there is seldom sufficient time for the soil to become properly settled before sowing. If such land is well prepared for the grain crop, a thorough disking followed by one or two harrowings will ordinarily leave the seed bed in fairly good condition. Land that has been in early potatoes, peas, or sweet corn can usually be prepared satisfactorily by removing the vines or stalks and harrowing. In preparing clover sod for alfalfa the land should be plowed as soon as the crop is removed and disked and harrowed until a firm fine seed bed is obtained. The preparation of sod land may be facilitated by cutting the sod with a disk before plowing. In semiarid regions summer fallowing is often practiced to insure satisfactory moisture conditions for the seedlings the following spring. This method is also effective in any section for ridding the ground of weeds, but it involves considerable expense.

LIMING.

No other of our commonly grown forage crops requires so much lime as does alfalfa. It is necessary not only to have enough to neutralize the soil but also an excess for the actual use of the plant. If there is any doubt about the need for lime, the question should be definitely settled before time and money are wasted in an effort to get alfalfa started. Litmus paper, which can be obtained at any drug store, is a simple though not always an infallible test for the need for lime. Take a handful of soil moist enough to squeeze into a ball and press against it a piece of the litmus paper. Handle the litmus paper carefully, with dry gloves, if necessary, so that it is not moistened in any way before bringing it in contact with the soil. The natural perspiration of one's hand may affect it. If the soil turns red litmus paper blue and does not change the color of blue litmus paper, it can safely be assumed that lime is not needed. On the other hand, if the soil turns blue litmus paper red it indicates the need for lime.

In the humid East it is safe to assume that all soils except those of limestone origin will require lime for alfalfa. Even limestone soils are often acid at the surface, and lime must be applied before alfalfa will succeed on them. Limestone soils that do not require additional lime occur in the black belt of Alabama and Mississippi and near Syracuse, N. Y., while limestone soils that need lime are found in the Shenandoah Valley. With the exception of the soils of the Pacific slope of the northwestern United States, which have a high lime requirement, most of the soils west of the ninety-fifth meridian do not require liming for alfalfa.

There are several different forms of lime on the market, such as burned lime, slacked or hydrated lime, ground limestone, oyster shells, and marls. Experiments have shown little difference in the final results from the use of different forms of lime provided an equal quantity of calcium oxid is supplied. Burned or hydrated lime may give quicker results, but ground limestone will eventually bring the same benefit. For correcting acidity, 1 ton of burned lime is equivalent to $1\frac{1}{2}$ tons of slacked lime or 2 tons of ground limestone. Marls vary so in composition that a chemical analysis of the material from each source is necessary to determine the percentage of calcium oxid.

The quantity of lime required depends upon the soil, but ordinarily is not less than 1 ton of burned lime or the equivalent of this in other forms of lime. In some cases much larger quantities are required.

The farmer should use whichever is cheapest, based upon the relative proportion of calcium oxid, which is the essential element so far as correcting acidity is concerned. Where the consumer pays the freight he should bear in mind that he not only will have to pay such charges on twice as much ground limestone as on burned lime but also will be to the additional expense of hauling and spreading 2 tons of the former to 1 of the latter to get the same benefit.

Where practicable it is well to apply part of the lime the season previous to sowing the alfalfa. This is particularly advisable where ground limestone or oyster shells are used, as the lime in this form

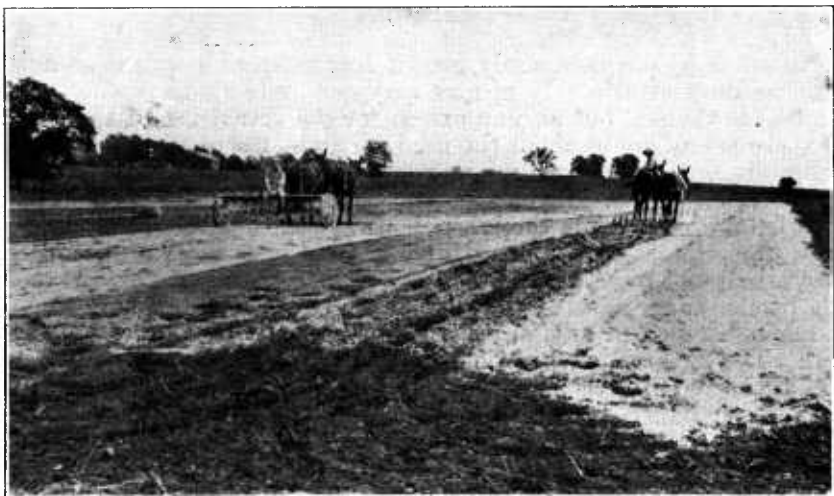


FIG. 4.—Liming for alfalfa.

is not as readily available as is the burned lime. Where it is not convenient to apply any part of the lime the preceding season, it may be applied after plowing, preferably three or four weeks before the seed is to be sown, and thoroughly incorporated with the soil. The lime may be applied with a manure spreader, a fertilizer distributor, a lime distributor, or by hand (fig. 4). Any method that spreads the lime evenly and at low cost is satisfactory. Top-dressing an alfalfa stand with lime is not recommended.

FERTILIZING.

Alfalfa being a heavy feeder requires an abundance of available plant food in the soil for its best growth. In addition to this there should be a liberal supply of humus for the proper development of the nitrifying organisms, without which the crop will in many cases be a failure. On most of the soils east of the ninety-fifth meridian alfalfa responds to some sort of fertilizer treatment. The greatest

need seems to be for phosphoric acid and humus, or decaying vegetable matter, and liberal applications of both will in most cases yield profitable returns.

Potash is an essential element, but most clay soils carry sufficient to meet the demands of the crop. Light applications, however, on sandy soils are nearly always beneficial. Alfalfa requires some nitrogen in the soil for its early growth, but after it is once established, other conditions being favorable, it is able to procure most of its supply from the air by means of the bacteria in the nodules on the roots.

Good barnyard manure furnishes not only humus but also other plant food required by alfalfa and for this reason is one of the most satisfactory fertilizers. It may be applied to the previous crop; it may be applied in the autumn and plowed under prior to sowing alfalfa; or it may be turned under in the spring where fall plowing is not practicable. It is always well to apply the manure long enough in advance so that it will become well incorporated with the soil. Where the quantity of barnyard manure is limited it may be made to go further by using some acid phosphate in connection with it. Where it is not available the humus may be supplied by plowing under some green-manure crop and by applying commercial fertilizers. In the North such crops as rye, vetch, and Canada field peas may be used. Farther south bur clover, crimson clover, soy beans, and cowpeas answer the purpose admirably.

If commercial fertilizers are used they should consist largely of acid phosphate, about 300 to 500 pounds per acre of 16 per cent acid phosphate, about 50 to 75 pounds of nitrate of soda to give the alfalfa a start, and 75 to 100 pounds of muriate of potash. The proportion of potash may be increased on sandy soils and decreased or eliminated entirely on clay soils.

Other forms of fertilizer may be used to supply the elements needed by alfalfa, such as cottonseed meal in the place of nitrate of soda and other materials which furnish phosphoric acid. Generally speaking, raw rock phosphate has not given as satisfactory results as acid phosphate, since it is much slower in acting than after it has been treated with acid. Most of the experiments that have been conducted in the East indicate that alfalfa is not appreciably benefited by applications of flowers of sulphur.

West of the ninety-fifth meridian many of the soils do not require any special fertilizer treatment for alfalfa. However, there seems to be an increasing number of cases where land that has given good yields of alfalfa for several years when reseeded failed for some reason to give satisfactory results, indicating a decrease in certain plant-food elements. In such cases the use of acid phosphate has proved highly beneficial. On some of the irrigated lands of the Northwest, particularly in Oregon, applications of 100 to 200 pounds per acre of flowers of sulphur have given greatly increased yields. In many cases, however, these fertilizers, if they produce any increase in the growth of alfalfa, do not give sufficient increase to justify the extra labor and money involved, and the farmer is advised to avoid any great expense in connection with their use until he has first determined on a small scale whether they will produce any appreciable benefit.

INOCULATION.

With the exception of the Pacific coast region of the northwestern United States, most of the soils west of the ninety-fifth meridian are naturally supplied with proper bacteria for inoculating alfalfa. In the eastern part of the country, however, where the soil conditions are less favorable to the growth of nitrogen-fixing bacteria it is nearly always necessary to supply them at the time of sowing, where alfalfa is grown for the first time. Fields that within the past few years have grown alfalfa, sweet clover, bur clover, or black medic successfully will not ordinarily need further inoculation for alfalfa.

The surest way of getting a new stand of alfalfa well inoculated is by scattering soil from a successful alfalfa field or from the roots of sweet-clover or bur-clover plants. In the past the general recommendation has been to use 250 to 500 pounds of soil per acre, the application of which is rather tedious and expensive. In some recent experiments equal quantities of soil and seed gave good results. This mixture may be sown broadcast or drilled. Where it is drilled in, only finely sifted soil should be used, and as the soil particles are inclined to work toward the bottom of the drill box it may be necessary to add a little occasionally or keep the seed well stirred. Moistening the seed with water to which has been added a little glue and mixing a small quantity of soil with the seed, although not always successful, has in many cases resulted in satisfactory inoculation.

Inoculation is also accomplished by means of artificial cultures, which are put out by most of the State agricultural experiment stations and several commercial firms. Instructions for use accompany these cultures.

The practice of sowing a small quantity of alfalfa with the regular sowing of clover or other hay-crop seed has in some cases apparently been the means of introducing sufficient bacteria for inoculating the succeeding crop of alfalfa.

Investigations indicate that a single inoculation should be adequate for many years, provided the soil is kept well supplied with organic matter and lime, even though alfalfa or sweet clover is not grown on the land. If the soil is allowed to become strongly acid or to lose a large part of its vegetable matter the bacteria decrease very rapidly.

SOWING ALFALFA.

METHOD OF SOWING.

The method of sowing varies considerably in different sections. It may be done with a grain drill with a seeder attachment or with an alfalfa drill (fig. 5), or the seed may be broadcasted with a hand seeder, a wheelbarrow seeder, or by hand and covered with a light harrow, a weeder, or a brush drag. Where the seed is drilled a somewhat lighter rate is required than where it is broadcasted, as better conditions are provided for germination. In order to insure a more even stand, it is best to sow half the seed one way across the field and the other half at right angles to the first sowing. The depth to which the seed should be covered depends on the character and condition of the soil. On heavy soil 1 inch is usually sufficient,

but $1\frac{1}{2}$ inches is preferable on sandy soils or on dry soils, to insure getting the seed in contact with moisture. The use of a cultipacker after sowing is of considerable assistance in making conditions favorable for the germination of the seed.

Good results are occasionally reported from broadcasting on honeycombed ground during late winter or early spring, but such a practice can be expected to succeed only under the most favorable conditions and can not be recommended for general use. In most parts of the country it is necessary to cover alfalfa seed, and good results can not be depended upon by leaving it on the surface of the ground, as is sometimes done with grass and clover. In a few instances sowing in corn at the last cultivation has given good stands, and yet it can hardly be termed a safe practice. With abundant rainfall and ideal soil conditions this method sometimes gives good

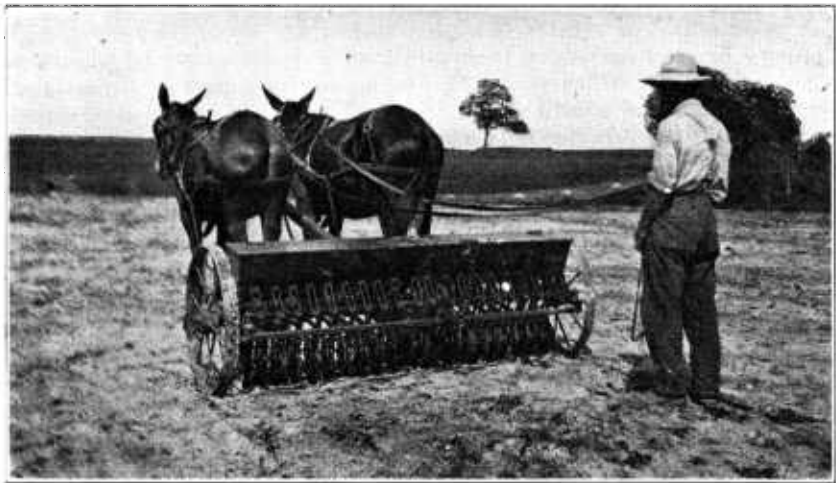


FIG. 5.—An alfalfa drill.

results. The presence of the stubble may be more or less troublesome in the first cutting the next season unless the corn is cut very close to the ground.

TIME OF SOWING.

The general principle underlying the time of sowing is to get the seed in the ground as far as possible in advance of what promises to be the most trying season for the young plants. In the Northeastern States late-spring or early-summer sowing is generally best, as this gives an opportunity for preparing a good seed bed and at the same time permits the plants to become thoroughly established before cold weather sets in. In the Southeast the most favorable time varies from the middle of August in the latitude of Washington to late October or early November along the Gulf coast. February and March sowings are sometimes successful in the extreme South, but late-spring and early-summer sowings are likely to be crowded out by the weeds.

In the northern part of the dry-farming area of the Great Plains it is almost necessary to sow the seed as early in the spring as the land can be put into shape, since moisture conditions are most favorable at this time. During the summer the soil usually is so dry that the young plants are not able to make sufficient growth to withstand the cold winters. In the southern part of this area, however, good stands are often obtained from late-summer and early-fall sowings.

In the irrigated districts of the Southwest October is the best month for sowing alfalfa, although good stands are obtained almost any time between October 1 and April 15. The hot summer months constitute the most unfavorable period. In the North the spring sowings are most satisfactory, although good stands have been obtained where the seed was sown in grain stubble in the late summer or early fall.

RATE OF SOWING.

A good stand of alfalfa is highly important from the outset. The quantity of seed necessary to insure a sufficient number of plants per acre varies with different parts of the country and is directly dependent upon the condition of the seed bed. If every seed should grow, 1 or 2 pounds per acre would be ample, but some of them are not viable and others are covered too deeply or else fall in dry soil and fail to germinate. Furthermore, many plants that start to grow succumb in the seedling stage, due to one cause or another. For these reasons it is always advisable to sow a larger quantity of seed than would be necessary under ideal conditions, particularly as the farmer seldom takes the time or goes to the expense of preparing an ideal seed bed. As the cost of the seed is a relatively small item, it is better to waste some by sowing more than is needed than to run the risk of a thin stand that offers a foothold for weeds. In the humid States the rate of sowing varies from 20 to 25 pounds per acre. The heavier rate is recommended for most of New England and the Atlantic and Gulf States, where the soils are not naturally suited to alfalfa and weeds give considerable trouble. In these States there are soils, however, particularly those of limestone origin, on which the lighter rate of sowing will be sufficient. On most of the soils in the Great Lakes States and in the western part of the humid area 20 pounds of seed is ample. Under dry-farming conditions 8 to 12 pounds of seed is advised, although good stands are sometimes obtained with 4 or 5 pounds. Under irrigation the quantity of seed commonly recommended is 15 to 20 pounds. The heavier rate should be used wherever weeds are likely to be troublesome, as is the case in some parts of the Southwest. In the northern irrigated districts good stands are obtained with 15 pounds of seed.

ALFALFA IN MIXTURES.

Because of its ability to produce two or more cuttings in a season alfalfa is not generally well suited to sowing in mixtures with grasses and clovers. Such data as are available seem to indicate that in so far as yield alone is concerned there is no advantage to be gained by the practice. In humid districts where more or less difficulty is encountered in curing alfalfa the presence of some grasses may be of appreciable value in hastening the process, and, furthermore, some feeders prefer mixtures to alfalfa alone. Grasses are

sometimes sown with alfalfa for pasturing to reduce the danger from bloat. Timothy is probably used in mixture with alfalfa more than any other grass because of its wide popularity. It is used to some extent in the East and to a considerable extent in parts of the Northwest where alfalfa is grown under irrigation. The mixture is also commonly sown at high altitudes. There are quite a number of farmers in the Northeast who make a regular practice of sowing a little timothy with alfalfa on the theory that when the alfalfa dies out the timothy will fill up the vacant spaces and check the growth of the weeds. Timothy, however, does not thicken its stand under meadow conditions. Orchard grass and meadow fescue are better suited for sowing with alfalfa than is timothy, as they mature more nearly with it.

In the northern Great Plains region, northwestern Missouri, and western Iowa smooth brome-grass gives fairly good results when sown with alfalfa. After a few years, however, the brome-grass forms such a dense sod that the surviving plants of alfalfa are unable to make a very vigorous growth in it. Kentucky bluegrass is not satisfactory, as it crowds out the alfalfa.

NURSE CROPS.

Where a nurse crop can be used without danger of decreasing the chance of securing a stand of alfalfa, it is quite desirable, as it gives some return from the land while the alfalfa is becoming established. Due consideration should be given to deciding whether this compensates for the probable lighter subsequent yields of alfalfa. The chief objections to a nurse crop are that it draws rather heavily on the moisture supply of the soil, and as it is harvested at a hot time of the year the sudden change from the shade offered by it to the bright sun is likely to prove injurious to the alfalfa seedlings. It is often claimed that the nurse crop assists in keeping down the weeds and is no harder on the alfalfa than the weeds would be if no nurse crop were used. Experience, however, has shown that where a good stand of alfalfa is the ultimate object sought it is safest in most cases to sow it alone. This is particularly true in the Eastern States, where the soil and climatic conditions are not naturally well suited to the crop. In the more favorable situations satisfactory stands are secured where the alfalfa is sown with about one-third of the normal rate of small grain in the early spring, but when the region is considered as a whole the percentage of failures runs so high that the practice can not be recommended. In the dry-farming regions, where moisture is the limiting factor, the use of a nurse crop is almost sure to prove disastrous except in seasons of abundant rainfall. Under irrigation the percentage of successful stands with a nurse crop runs somewhat higher. The practice is quite commonly advised in spring sowings in the northern irrigated districts, but farther south it is considered a better practice to sow the alfalfa alone. The nurse crop is seldom used with late summer or fall sown alfalfa, except occasionally in the Southwest.

Where alfalfa is sown with a nurse crop, spring wheat, barley, oats, or flax is most commonly used. Such evidence as is available indicates that in regions adapted to it flax is one of the safest nurse

crops for alfalfa. It is usual to recommend that the rate of sowing of the nurse crop be very light, not more than one-third or one-half the regular rate. The nurse crop should be cut as soon as it shows any evidence of injuring the alfalfa. It is generally safer to cut it for hay than allow it to mature. In parts of the Northeast good stands are secured where alfalfa is sown with canning peas, as they come off early and are less injurious to the young seedlings than are the small-grain crops.

GROWING ALFALFA IN ROWS.

A few years ago there was much interest in growing alfalfa in cultivated rows in the belief that the practice had considerable promise for regions of limited rainfall (fig. 6). It was hoped that in



FIG. 6.—Alfalfa in cultivated rows.

such regions it would be possible to produce satisfactory yields of hay and seed in this way. Farmers as well as investigators of the United States Department of Agriculture and several State experiment stations have given the method a thorough trial. The results of these tests indicate that where the rainfall is not sufficient to produce profitable yields of hay in broadcast or close-drilled fields it is likewise too dry for alfalfa in cultivated rows. Where the rainfall is very limited the yield from rows is somewhat greater than from the close-drilled fields, but this is not sufficient to justify the extra expense involved. The cultivation necessary to keep down weeds adds considerable to the expense of growing the crop. Moreover, the hay is of a poorer quality, as it is dusty and contains many small clods of dirt.

With a limited moisture supply alfalfa in rows ordinarily will give somewhat larger yields of seed than close-drilled or broadcast

stands, but the increase seldom is enough to pay the additional cost of producing the seed. Where a thin broadcast stand does not give a profitable return there is little use in attempting to grow seed in rows unless it is of an unusual variety that commands a sufficiently high price to insure a profit in spite of the low yields.

INSTRUCTIONS FOR GROWING ALFALFA BY SECTIONS.

MICHIGAN, WISCONSIN, MINNESOTA, NEW YORK, AND THE NEW ENGLAND STATES.

Due attention should be given to the need for lime, fertilizer, and inoculation, as heretofore mentioned. Land that is intended for alfalfa should be in some cultivated crop, such as corn or potatoes, for one or two years prior to sowing. The ideal seed bed is obtained by plowing in the fall, disking in the spring, and harrowing occasionally to keep down the weeds until sowing time. Good stands are also obtained following the removal of early potatoes or early truck. Such land requires little further preparation for alfalfa provided the vegetable crop has been well cultivated. It is seldom safe to sow alfalfa after a crop of small grain has been removed, as there is barely time for it to become thoroughly established before cold weather, and, moreover, the moisture supply may be limited, due to the demands of the preceding grain crop.

On the poorer soils or where weeds are likely to be very troublesome the best rate of sowing is 25 pounds per acre. Under more favorable conditions 20 pounds is ample.

The most successful stands are obtained from sowing the seed alone in June or early July, but when this is done no return is obtained from the land the first year, and for this reason many farmers prefer to take a chance on sowing later after some other crop has been removed. In the States specified above it is seldom, if ever, advisable to sow later than August 15, and even this date is rather risky. Under favorable conditions good stands follow the practice of sowing alfalfa in the spring with a small grain as a nurse crop. It is safest to sow the nurse crop at a light rate, about 2 to 4 pecks per acre, and cut it early for hay. Successful stands are also obtained from sowing with early canning peas.

OHIO, INDIANA, ILLINOIS, IOWA, MISSOURI, KENTUCKY, PENNSYLVANIA, NORTHERN NEW JERSEY, AND WEST VIRGINIA.

On most of the soils in this region lime, inoculation, and some sort of fertilizer treatment are essential for the best growth of alfalfa. Discussions regarding these features will be found elsewhere in this bulletin. The surest way to secure a stand is to plow in the fall or early spring and fallow the land until August, but this method is often objected to because of the expense involved. Practically as good results are secured where the seed is sown after an early crop of sweet corn, potatoes, or truck. Such land requires little preparation for alfalfa provided it has been well cultivated. Small-grain crops usually mature early enough for late summer sowings of alfalfa, but there is very likely to be a deficiency in the soil moisture at this time, due to the demands of the previous crop. An early crop of red

clover may also be taken off soon enough to get the land into shape for alfalfa the same year. Such land will require considerable preparation, as it will need to be plowed and thoroughly worked before it is safe to sow alfalfa.

The quantity of seed required varies with the perfection of the seed bed, the character of the soil, and the condition of the weather at sowing time. Under average conditions about 20 pounds per acre has proved sufficient.

If the weather is favorable and the soil in good condition and free from weeds it does not seem to make much difference when the seed is sown, so long as there is sufficient time for the plants to become well established before winter starts in. During midsummer, however, the weather is usually too hot and the soil too dry to insure the successful germination and growth of the seedlings.

Better results are obtained when the seed is sown about corn-planting time or else delayed until August. Early-spring sowings sometimes prove satisfactory where the soil is in good condition and comparatively free from weeds.

There is considerable disagreement as to the advisability of using a nurse crop, but it is rather generally conceded that summer and fall sowings had better be made alone. Early-spring sowings with one-third to one-half the normal quantity of seed of some small-grain crop seem to do little damage to the alfalfa if the crop is cut early for hay. Early canning peas have also been successfully used as a nurse crop.

THE SOUTHEASTERN STATES AND THE GULF COAST.

The soils in this region with few exceptions are not naturally well suited to the production of alfalfa, and careful attention must be given to preparing the land for the crop. Consideration should be given to liming, inoculation, and fertilizing, which have been discussed previously. Weeds are especially troublesome in this section, and for this reason alfalfa should be preceded for one or two years with crops which are either clean cultivated or with such a crop as cowpeas, which chokes out the weeds. Corn and cotton are good preparatory crops. Early truck and potato crops furnish excellent opportunities for destroying weeds and may generally be taken off the land in time for sowing alfalfa. These crops leave the land in such shape that plowing is not necessary. Red or crimson clover or rye and vetch can be cut up with a disk, then turned under, and the land prepared for the late-summer or early-fall sowing of alfalfa. A common practice in the southern part of the region is to sow winter grain after a crop of corn or cotton has been removed. The grain is harvested in the spring and the land plowed and sowed to cowpeas as soon as possible. In the latter part of the summer the cowpeas are cut up with a disk, and the land is plowed and prepared for sowing by the latter part of September or early in October. Farther north the same system may be used, but the crop of cowpeas should be cut for hay and the land disked and harrowed for alfalfa. It is not advisable to plow under the cowpeas as far north as Virginia, as there is not time for them to decompose and the land to settle before the alfalfa is sown. In sections where considerable

silage corn is produced, successful stands are sometimes obtained from sowing after the corn is removed.

Alfalfa should be sown without a nurse crop at the rate of 20 to 25 pounds per acre. In the Piedmont sections good stands are secured with 20 pounds, but in the Coastal Plains where the soils are sandy and weeds troublesome less than 25 pounds per acre is not advisable.

In the northern part of the region under consideration sowings made about the middle of August on the average have given the best results. In the South Atlantic and Gulf States the date of sowing may be delayed with safety until the middle of October, and when weather conditions are especially favorable successful stands are sometimes obtained from sowings made as late as the 1st of November, although they are not recommended. Early spring sowings—that is, in March—are sometimes successful in the extreme South.

SEMIARID CONDITIONS.

Alfalfa is grown quite extensively in parts of the West where the rainfall is limited and where water is not available for irrigation. In this region the soil-moisture conditions are usually most favorable in the spring, and in the North it has generally been considered the best practice to sow as early in the spring as the ground can be put in shape; but recent experiments indicate that, in some sections at least, weeds are less troublesome where sowing is delayed until the 1st to the 15th of May. This gives opportunity to work up the seed bed two or three times, thus destroying many of the weeds. If sowing is delayed until the weather is hot and dry, there is danger that the plants will not become well enough established to survive the winter. South of Kansas the seed may be sown either in the spring or early fall. Moisture conditions usually are most favorable in the spring, but weeds are likely to prove more troublesome when the seed is sown at this time. For this reason many growers prefer to keep the land cleanly cultivated during the summer and sow the seed in the late summer or early fall.

Preparation for alfalfa should begin somewhat in advance, to insure sufficient moisture for the young seedlings. Where the seed is to be sown in the spring the land should be summer fallowed the previous year or else devoted to some cultivated crop, such as corn, to assist in freeing it of weeds and to conserve the moisture. Except on heavy soils it will not be necessary to plow again, but where it seems advisable it should be done in the fall and the land disked and harrowed as soon as it is in condition to work the following spring. Land to be sown in the late summer or early fall should be plowed the previous fall and kept cultivated throughout the spring and early summer.

The use of a nurse crop is not recommended under dry-land conditions, as it draws too heavily on the rather limited moisture supply. However, good stands are frequently obtained with one-third or one-half the normal rate of sowing of some small-grain crop, particularly where it is cut early for hay. Good results are also secured from the use of flax as a nurse crop.

Over most of the dry-farming area less seed is required than is advised under humid conditions or under irrigation, partly owing to the fact that weeds are less troublesome. Ordinarily, from 10 to

12 pounds of seed per acre will be ample. Good stands have been obtained with 2 to 4 pounds, but such light rates can not be recommended for general practice.

SANDY SOILS.

In the Eastern States alfalfa usually does not survive long on very sandy soils, although fairly good yields may be obtained for two or three years where liberal applications of stable manure are made prior to sowing the seed. West of the Mississippi River such soils, if not too sandy, usually will grow alfalfa successfully after the plants are once well established. However, it is often difficult to start the crop on soils that are so light in texture that they drift badly, as the young plants are likely to be cut off by the sand unless special precautions are taken. This may be avoided by applying a light top-dressing of straw or coarse manure just after sowing. Another method that has proved quite satisfactory is to scatter a thin layer of wild hay or straw from an old stack bottom over the land immediately after the seed has been sown. The field is then gone over with a weighted disk set straight. This cuts the hay into the ground and leaves it standing over the field, much like stubble. Good results are also had where the alfalfa is drilled into high-cut stubble of sorghum or millet. Where cornland is used and the field is in good shape, it may be prepared by disking down the stalks early in the spring and leaving the soil rough until time for sowing. The alfalfa seed may also be sown with about a peck per acre of rye, barley, or some other small-grain crop which will make a rapid growth and protect the young alfalfa seedlings. Unless there is danger of injury from drifting soil the nurse crop should be avoided, as it is likely to draw so heavily on the soil moisture as to injure the alfalfa.

The rate of sowing generally advised is from 10 to 15 pounds per acre. The press drill gives the best results, but where this is not available the seed may be sown broadcast, the land harrowed, and then rolled to get the seed into contact with the moist soil and hasten germination. After rolling, it is best to harrow the soil lightly so as to reduce the possibility of the formation of a crust on the surface.

SOWING ALFALFA UNDER IRRIGATION.

In preparing land for alfalfa the first step is to break it deeply and then level it if necessary. Plowing should be done several weeks in advance of sowing, so that the soil may be properly compacted by the use of a heavily loaded disk, a roller, or some other suitable implement. Ordinarily it is best to irrigate the land just prior to sowing the seed, and as soon as it has dried out sufficiently the surface should be worked up into a fine mellow seed bed. If possible, further irrigation should be avoided until the plants have developed three or four leaves. Good stands are sometimes obtained where the seed is "irrigated up," but the practice is not recommended, particularly on heavy soils, as the surface often becomes so crusted that the young plants are unable to break through.

For ordinary conditions the rate of sowing should be about 15 pounds per acre, although a smaller quantity may give good stands

under ideal conditions. Generally speaking, somewhat less seed seems to be required in the northern irrigated districts than farther south, probably because weeds are somewhat less troublesome. The time of sowing will depend upon frost conditions, but should be early enough to allow the plants to become well established before cold weather. In the extreme Northern States the best stands are obtained where the seed is sown as early in the spring as it is possible to get the land in condition. Ordinarily, at this time of the year the soil contains considerable moisture as a result of the winter precipitation, and irrigation prior to sowing is not essential. Another advantage of early-spring sowing is that during the cool weather the soil does not dry out very rapidly, so that the plants have an opportunity to become well established before irrigation is necessary. In Montana and the Dakotas the latter part of April or early in May is about the earliest date that alfalfa can be sown safely. Under favorable conditions in these States good stands have been obtained where seed was sown on disked grain stubble in the late summer. In the extreme Southwest good stands may be secured from sowing almost any time between October 1 and April 15, although the December and January sowings are occasionally injured by cold weather. October is the most favorable month, but where it is impossible to get the land in shape in the fall February and March sowings usually give quite satisfactory results. The hot summer months constitute the most trying period.

As a rule, the best stands are secured where the alfalfa is sown alone. In the Northern States, however, a nurse crop is not particularly objectionable, provided it is sown at about one-half or one-third the usual rate. In the Southwest it is best to avoid the use of a nurse crop.

TREATMENT.

Late summer or fall sown alfalfa requires no treatment that season. Even though the plants make considerable growth before being checked by frost, they should not be cut. Where alfalfa is sown in the spring weeds usually appear in abundance, and the important question is whether it is better for the alfalfa to keep the weeds cut back or allow them to grow. There is a generally prevailing theory that the frequent cutting of young plants forces them to stool out and increases root growth, but carefully controlled experiments have demonstrated quite clearly that such treatment actually checks root development. Even where the weeds are very bad, such evidence as is available indicates that it is better to delay clipping until the young alfalfa plants have reached the proper stage; that is until they are in bloom. While the earlier clipping may check the weed growth to some extent, it also weakens the alfalfa seedlings and lessens their ability to compete with the weeds.

When the field is cut the growth should be removed if there is any danger of smothering the seedlings; otherwise it may be left on the ground as a mulch. In the Northern Great Plains and intermountain region the weeds in alfalfa have been allowed to go unclipped throughout the first season, the subsequent stand of alfalfa benefiting by such treatment. Where this is done it is advisable to get rid of the dead growth early in the spring. In the North,

where only hardy alfalfas are grown, this has been accomplished by burning over the fields, but the more tender alfalfas are sometimes injured by such treatment. Where it is not safe or convenient to burn off the fields the dead growth may be raked up and hauled off. In the South and Southwest it is often possible to procure two or three cuttings of hay the first year from spring sowings, and where this is the case the recommendations made above do not apply.

Alfalfa should not be pastured the first year, and only lightly the second year. It should never be pastured closely, as the grazing down of the crowns often results in killing the plants. Cattle should never be allowed access to a field when the ground is wet or frozen. Owing to the difficulty of securing a good stand in the East, it is very doubtful whether alfalfa in that section should be pastured at all.

If the stand becomes thin or patchy the field should be plowed up and reseeded after it has been planted to some other crop for a year or more. Attempts to patch up poor stands generally prove futile.

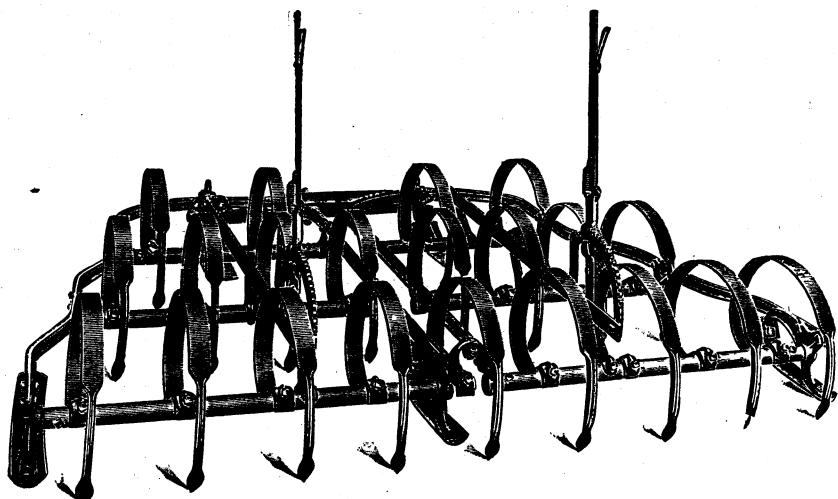


FIG. 7.—Type of harrow commonly used in cultivating broadcast alfalfa.

In the East a top dressing of well-rotted stable manure applied in the late fall or winter not only furnishes some protection, but in most cases also will increase the yield the following season. If stable manure is not available, an application of 300 to 500 pounds of acid phosphate per acre in the spring is of considerable assistance in maintaining the vigor of the stand.

CULTIVATING ALFALFA.

For many years writers have advocated the disking or harrowing of alfalfa fields, on the ground that it increases the yield and prolongs the life of the stand. While some form of cultivation appears advisable under certain special conditions, any general statement to the effect that alfalfa fields are always benefited by such treatment is certainly open to question. Where irrigation waters leave thick deposits of silt on the field the use of the harrow to break up such deposits appears advisable; also where irrigated alfalfa is

pastured, some sort of cultivation to loosen the soil that has been compacted by trampling, particularly the heavy-textured soil, may be beneficial. Where weeds and grass threaten to crowd out the alfalfa the life of the stand may often be profitably prolonged for a year or two by harrowing. Generally speaking, however, there is little or no advantage to be gained by cultivating broadcast alfalfa so long as the stand is satisfactory and the plants are making good growth. Extensive experiments have shown that under such conditions the increase in yield, if any, is not sufficient to pay the additional cost of producing the crop, and the life of the stand is prolonged but slightly, if at all.

The best implement for cultivating alfalfa is the so-called alfalfa harrow, which is a modified form of the spring-tooth harrow. (Fig. 7.) This implement loosens the soil without seriously injuring the plants. The spike-tooth harrow will loosen up the lighter textured soils, but is of little benefit on the heavy soils. Experience has shown that in most cases the use of the disk harrow is actually injurious, as any implement that has a tendency to split the crowns renders the plant more susceptible to certain diseases.

The best time for cultivating a field of alfalfa will depend upon the object to be gained. Ordinarily it should be early in the spring or immediately after any one of the cuttings. Alfalfa should never be cultivated the first year after sowing, as the plants are so small that they are easily pulled out and killed.

MAKING ALFALFA HAY.

Most of the alfalfa grown in this country is cut for hay. The number of cuttings obtained depends upon climatic conditions, the soil, and the variety, and varies from eight or sometimes more in the far Southwest to two and sometimes only one in the North and semi-arid sections. From 30 to 40 days are required to produce a hay crop.

Alfalfa should be cut when the plants are well in bloom. Cutting at an earlier stage of growth gives hay of a higher protein content, but the stands are maintained in better condition if cut when nearer full bloom. In the East, alfalfa sometimes blooms very sparingly when the season is too wet or too dry, so it is very difficult to determine the stage of maturity by the number of blossoms. When this is the case it becomes necessary to watch the basal shoots and cut the alfalfa when they are well started. As the leaves contain about two-thirds of the feeding value of the plant, an effort should be made to get the hay in the stack or mow with as large a proportion of leaves as possible. This can be accomplished only with a minimum amount of handling after the hay begins to dry. The hay should be raked before it becomes brittle, and most of the curing should be done in the cock. In humid sections hay caps, each consisting of a piece of canvas about 3 feet square, are helpful in making a good quality of hay, but they increase the labor and expense. Where the weather is uncertain the farmer may be justified in hastening the process by doing more curing in the swath and finishing in the windrow. By this method the hay is exposed for a shorter time between cutting and storing, and while some leaves are lost the actual loss in feeding value may be less than would result from unfavorable weather even though the hay were in the cock.

The least loss is sustained where the hay is placed in the barn, but in the big alfalfa districts such space is not available and most of it is stacked (fig. 8). Many of the stacks are carelessly built and left unprotected in spite of the fact that the saving effected nearly always justifies some sort of covering and the effort involved in building a well-shaped stack. Canvas, boards, corrugated sheet iron, or coarse grass may be used to cover a stack of alfalfa. The stacks should be as large as practicable, and in order to shed water properly they should be somewhat larger at a height of 6 feet than at the base. Alfalfa should not be put in the barn too green, as it is likely to heat and in extreme cases has been known to become so hot as to cause a fire. Where hay is stacked before it is properly cured, fermentation takes place, resulting in a brown hay. Experiments indicate that good brown hay is somewhat superior to green hay in palatability, but not superior to it in feeding value.

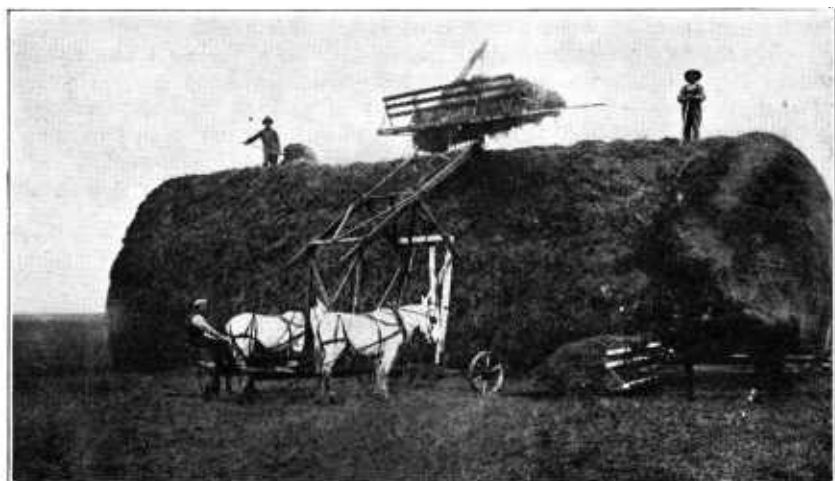


FIG. 8.—Stacking alfalfa.

USES OF ALFALFA.

Well-cured alfalfa is more readily eaten by all classes of farm animals than any other kind of hay. Chemical analyses show little difference in alfalfa hay and that made from certain other legumes, such as cowpeas, soy beans, and clover, but it is generally somewhat more palatable. As a pasture plant alfalfa is relished highly, and fields of it have a large carrying capacity; but if it is utilized in this way considerable caution should be taken, as a good stand is easily injured by overgrazing (fig. 9). Alfalfa should never be pastured the first year and only lightly the second year. Because of the difficulty encountered in the East in getting a good stand, the advisability of pasturing in that section at any time is open to question. Ordinarily hogs are less injurious to alfalfa than other classes of livestock. Care should be taken in pasturing sheep and cattle on alfalfa, as they are subject to bloat. This does not apply to horses, mules, and hogs.

Good silage may be made from alfalfa, provided the material is finely cut and thoroughly packed, but as ordinarily put in the silo it does not keep as satisfactorily or as long as silage made from corn. Its chief disadvantages are the labor involved in putting it up and the lack of sufficient tonnage. Where it is possible to make good hay it seldom pays to make silage of alfalfa. Alfalfa makes an excellent soiling crop so far as yield is concerned, but it should be cut no oftener or no earlier in the stage of development than when it is cut for hay. In parts of the West large quantities of alfalfa are ground into meal. Much of this meal finds its way to the eastern markets either unmixed or mixed with molasses and various feeds. The mere grinding of the hay into meal does not increase its feeding value, but it is fed with less waste and is in convenient form for city and town use. It also gets the benefit of a considerably lower freight rate than hay. Attempts have been made to extend the use of alfalfa



FIG. 9.—Dairy cows grazing on alfalfa.

to the making of human food, medicines, textiles, dyes, and other commercial products, but the plant has little or nothing to commend it for such uses.

SEED PRODUCTION.

Alfalfa produces seed in paying quantities only where the summer rainfall is comparatively light. For this reason the commercial production of alfalfa seed in the United States is confined largely to that portion lying west of the ninety-fifth meridian. The seed production by States in this region for 1909 is shown on the accompanying map (fig. 10). Most of the seed of the Grimm variety is produced in Idaho, Montana, North Dakota, and South Dakota. The Peruvian alfalfa seed industry is confined almost entirely to the Yuma Valley of California and Arizona. Only a small quantity of seed is grown east of the ninety-fifth meridian, as alfalfas do not produce seed satisfactorily under humid conditions. Ordinarily it

is more profitable for the farmer in the Eastern States to purchase seed that is produced in the West rather than attempt to grow it himself.

For its best development the alfalfa seed crop requires a hot, dry season, and as a result it is customary to save that crop for seed which matures during the hottest and driest part of the summer. Over much of the country this is the second crop, but south of Kansas it may be the third crop. In the extreme North the season is usually so short that it is necessary to leave the first growth for seed. For a short time in the spring, some growers pasture fields that are to be devoted to seed production.

For a seed crop alfalfa should be cut when two-thirds to three-fourths of the pods have turned brown. The crop may be harvested

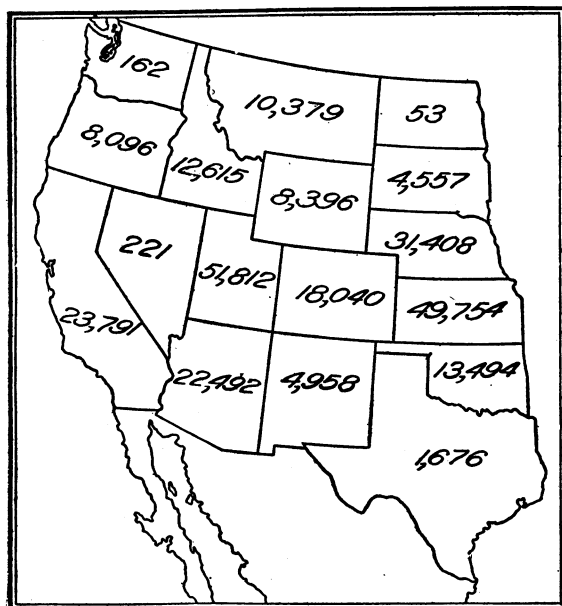


FIG. 10.—Map showing the production of alfalfa seed, in bushels, in the States west of the ninety-fifth meridian, according to the census of 1910.

alfalfa seed in the United States in 1924 was approximately 46,000,000 pounds. In addition to this, about 4,700,000 pounds was permitted entry from abroad.

BREAKING ALFALFA SOD.

Farmers often complain of the difficulty of breaking up and destroying a stand of alfalfa, but under most conditions this need not offer any serious objection to the crop provided the necessary equipment is at hand; that is, strong horses and a sharp plow. The plow should be in good condition when it enters the field, and the operator should carry a file to keep it sharp. It is of course more difficult to keep the plow in condition in gravelly or stony soil.

with a mower having a bunching attachment or with a binder having the tying attachment removed. This leaves the alfalfa in convenient forkfuls and reduces shattering in handling. Where possible, alfalfa is threshed from the field, but in some cases it is necessary to stack it. An alfalfa huller is the most satisfactory thresher, although the ordinary grain thresher equipped with alfalfa sieves and with the concaves screwed down does quite satisfactory work. The average yield of seed per acre runs from 2 to 5 bushels. The total production of

The furrow slice should be 2 inches less in width than the plow will turn. This is to prevent any of the large roots from slipping by uncut. Sometimes the plows are provided with a knife attachment to the landside to cut the roots near the outer edge of the next furrow. The most successful practice is to plow shallow in the fall and deep the following spring. Where only one plowing is practicable this should be rather shallow. If plowed too deeply the roots frequently retain enough life to start again. Ordinarily it is better to leave the furrow slice to dry out some time before cultivating, as this assists in killing the roots.

WEEDS.

In most of the United States weeds constitute the worst enemy of alfalfa. Dodder, a threadlike yellow twining plant which lives as a parasite on plants, is very objectionable in seed-producing districts, as there is little or no market for alfalfa seed that carries seeds of dodder with it, and the two seeds are very difficult to separate. Dodder seldom gives much trouble in fields that are devoted entirely to the production of hay. Other troublesome weeds are Kentucky bluegrass and quackgrass in the northeastern one-fourth of the United States; crabgrass and Bermuda grass in the Central and Southern States; and foxtail or wild millet in the Middle West and the Great Plains. In the irrigated sections of the West the wild barleys, also known as foxtail and squirreltail grass (*Hordeum* spp.), are decidedly troublesome, as the beards ruin the first crop of hay for feeding unless it is cut very early. Where weeds are troublesome in the West, wheat is sometimes drilled in the alfalfa in the fall, and as it comes on early the growth of the weeds is checked. The first cutting of hay the following spring consists of a mixture of alfalfa and wheat. Cultivation of established stands of alfalfa may help to hold the weeds in check, but unless done with considerable care the alfalfa may be injured. The most satisfactory way to control them is to make the conditions so favorable for alfalfa that the weeds are smothered out. When they become abundant it is better to plow the field rather than attempt to get rid of them by cultivation.

DISEASES.

Probably the four most destructive diseases in the United States, so far as alfalfa is concerned, are brown root-rot, *Ozonium omnivorum* Shear; crown-wart, *Urophlyctis alfalfae* (Lagerh.) P. Magnus; leaf-spot, *Pseudopeziza medicaginis* (Lib.) Sacc.; and yellow leaf-blotch, *Pyrenopeziza medicaginis* Fekl.

Brown root-rot results from a fungous parasite upon the roots of alfalfa, causing the plants to die out in well-defined, usually circular areas, which gradually increase in size. It occurs from eastern Texas to southern California and is the disease which attacks cotton and other taprooted plants. Land on which the root-rot occurs should be planted to some fibrous-rooted crops, such as corn, sorghum, or some small grains, for several years until the fungus has disappeared.

Crown-wart has been observed in many of the States west of the Mississippi River, but it occurs in the greatest abundance in

California. The disease is characterized by the appearance of galls on the crown at the base of the stems. These galls, which are caused by a fungus, are much warted externally and vary in size from $\frac{1}{8}$ to 3 or 4 inches in diameter. Affected plants are seldom killed outright; but the growth is checked and the plants weakened, resulting in smaller yields. Where the disease becomes serious it is advised that the land be plowed and put into some other crop until the gall fungus is eliminated.

Leaf-spot (*Pseudopeziza medicaginis*) is a fungous disease, which is very common where alfalfa is grown and may develop in all conditions of soil and weather. It is more destructive in humid than in dry sections. The disease is characterized by small brown spots about the size of a pinhead which are present on both sides of the leaves. Badly affected leaves turn yellow and drop off, thus reducing the yield and feeding value of the hay. Ordinarily the disease is not severe enough to require special attention, but where the field becomes very badly infected it is recommended that the crop be cut and removed.

Yellow leaf-blotch is also a fungous disease which is common in all large alfalfa-growing regions of the United States. The disease attacks the leaves and is characterized by long yellow blotches which are sprinkled with minute brown dots. It is not usually very serious, but where it becomes too bad it is best to cut the crop.

Yellowing.—One of the most serious of all the alfalfa troubles in this country is what is known as “yellowing.” This trouble is serious because it is undoubtedly responsible for a greater reduction in the annual yield of hay in the East than any of the diseases or insects. Yellowing has been observed rather frequently in the West in the past few years, but it has been known in the East almost as long as the crop has been grown on a commercial scale. The cause for this condition has never been determined. It has been attributed to some unfavorable soil condition, as a trouble that has almost identically the same symptoms occurs in the absence of sufficient lime, plant food, or drainage. However, yellowing is quite common where all these conditions are apparently favorable, as is shown by the quick recovery of the plants after the old growth has been removed. This shows that, in such cases at least, the yellowing is of a temporary nature. Where such a condition is due to lack of lime, plant food, etc., the plants make little, if any, recovery after cutting and soon die. This suggests that the trouble is pathological. The treatment advised is to cut the yellowed fields regardless of the stage of development. Usually the new growth comes on normally.

INSECTS.²

So far as alfalfa is concerned, it is probable that grasshoppers do more damage than any other insect. They occur in all parts of the country, but are most destructive in the arid and semiarid districts. The most effective means of control is by the use of poison-bran mixtures. The formula generally recommended is made up as follows: Wheat bran, 25 pounds; Paris green or white arsenic, 1

² Additional information on alfalfa insects may be obtained from the Bureau of Entomology, United States Department of Agriculture.

pound; 6 finely chopped lemons or oranges; low-grade molasses, 2 quarts; water, 2 to 4 gallons. The bran and Paris green or other arsenical are thoroughly mixed while dry. The finely chopped fruits are then added, and finally the diluted molasses is poured over the bait and the whole thoroughly kneaded. This quantity will treat about 3 acres when the grasshoppers are small, and when full grown it will suffice for 5 acres if sown broadcast in strips 1 rod apart. The mixture is ordinarily broadcasted by hand, although a broadcast grain seeder has been used successfully in the West. In semiarid climates it should be sown in the early morning, not later than 9 o'clock, but in the East it is recommended that it be sown before sunrise. In Montana, Wyoming, and the Dakotas amyl acetate at the rate of three-fourths of an ounce to 25 gallons of water has proved as effective as the citrus fruit and much cheaper. Other means of control suggested are the use of hopperdozers or other grasshopper traps where the land is fairly level, fall cultivation to destroy the eggs, and burning waste places at night. Turkeys are of some assistance in reducing the number of grasshoppers.

The alfalfa weevil is quite destructive in parts of the West. It made its first appearance in Utah in 1904 and has spread to Idaho, Nevada, western Colorado and Wyoming, and eastern Oregon. The insects feed on the green leaves and where numerous cause considerable damage. Cultivation after the first crop of hay has been removed assists somewhat in controlling this pest, but the most effective means is through the application of arsenate of lead, the powdered form being mixed with water to form a spray. The approved formula is 2 pounds of arsenate of lead powder to 100 gallons of water, this quantity to be applied as a spray to 1 acre of alfalfa. Where this application is made at a time when the growing tips of the plants are beginning to show serious injury from the weevil, it results in the complete control of the insect for the current season, subsequent cuttings of the crop usually being practically free from the pest.

The alfalfa-seed chalcis fly is more or less destructive in seed-growing districts, particularly in the Southwest. The eggs are deposited in the soft seed, and all stages of development are completed within the seed. Means of control recommended are the burning of check ridges, ditch banks, and fence lines, and the planting of clean seed only. It is also advised that the crop be harvested as soon as most of the seed pods are ripe. The amount of damage may be controlled to some extent by making the seed crop at a time when the chalcis fly is least abundant. This is accomplished in the South by cutting the first two crops for hay, leaving the third to produce seed, and in the North, where the season is long enough, by removing one hay crop and making seed from the second.

The garden webworm occurs over the whole United States but seldom is the cause of any great amount of damage to alfalfa. It webs together the tops of the alfalfa stems and the larvæ feed on the leaves. The webworm is controlled by cutting infested fields and burning or cutting the grass and leaves along the fence line.

The clover root-borer attacks the roots of alfalfa, boring out longitudinal channels and finally killing the plants. The damage from this pest is seldom widespread. Badly infested fields should be plowed immediately after the hay crop has been removed.

The clover-root curculio also attacks the roots, destroying the smaller and eating a channel on the outside of the larger roots. The damage caused by this insect is seldom extensive. The treatment suggested is the destruction of all weeds along the fences and harrowing the alfalfa fields after cutting.

The clover stem-borer injures the alfalfa plants by boring out the center of the stems. It is widely distributed throughout the United States but is seldom very destructive. Rotation, clean farming, and the cutting of the crop before the larvæ have had a chance to complete their development assist in keeping the pest under control.

The garden flea-hopper injures the plant by sucking its juices and sometimes causes considerable injury to alfalfa in the South and West. Cutting infested fields and spraying with a 10 per cent kerosene emulsion is recommended.

The alfalfa caterpillar has at times been reported as doing considerable damage to alfalfa in parts of the Southwest. Cutting followed by thorough and frequent irrigations assists in controlling it.

Eelworms, or nematodes, live in the soil and gain entrance into the root, where they cause enlargements of irregular shape and size. Affected plants are stunted and pale colored. It is suggested that crops resistant to eelworms be grown where this pest is abundant.

Various cutworms and army worms are destructive at times, but they usually become so parasitized by the middle of the summer that they give little or no trouble the following year. They may be controlled by the simple application of the poisoned bait recommended for the control of grasshoppers.

Other insects that have been reported as doing more or less damage to alfalfa at times are blister beetles, crane flies, the large red harvester ants, thrips, the tarnished plant-bug, the alfalfa looper, etc.

RODENTS.

The worst animal pests in growing a crop of alfalfa are gophers, ground squirrels, prairie dogs, and mice. They are especially troublesome in the western half of the country, where they eat the roots of the plants. Where irrigation waters are available they are controlled to some extent by drowning. Poisoning and trapping are the best means of holding them in check, but because of the danger attending the careless use of poisons it is suggested that the farmer get in touch with the county agricultural agent or a representative of the Bureau of Biological Survey of the United States Department of Agriculture whenever these pests become troublesome.

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